



5820

IMAGE ORTHICON

Magnetic Focus
Magnetic Deflection

For Outdoor and Studio Pickup
Exceptional Sensitivity

3"-Diameter Bulb
15-3/16" Length

RCA-5820 is a television camera tube intended for both outdoor and studio pickup. It has exceptionally high sensitivity combined with a spectral response approaching that of the eye.

The 5820 is very stable in performance at all incident light levels on the object ranging from bright sunlight (several thousand foot-candles) to a deep shadow (one foot-candle or less). Commercially acceptable pictures can be obtained at incident light levels greater than about 10 foot-candles with appropriate setting of the camera lens stops.

The photocathode utilized in the 5820 is characterized by a spectral response having high blue sensitivity, high green sensitivity, very good yellow sensitivity, good red sensitivity, and practically no infrared sensitivity. This latter characteristic of the response prevents any color-masking by infrared, and thus permits gray-scale rendition of colors in nearly their true tonal gradation.

Under proper operating conditions, the 5820 has light transfer characteristics which do not require the use of gamma-correction circuits to provide normal tone rendition in black-and-white pictures on the picture-tube screen.

PRINCIPLES OF OPERATION

The 5820 has three sections—an image section, a scanning section, and a multiplier section, as shown in Fig. 1.

Image Section

The image section contains a semitransparent photocathode on the inside of the faceplate, a

grid to provide an electrostatic accelerating field, and a target which consists of a thin glass disc with a fine mesh screen very closely spaced to it on the photocathode side. Focusing is accomplished by means of a magnetic field produced by an external coil, and by varying the photocathode voltage.

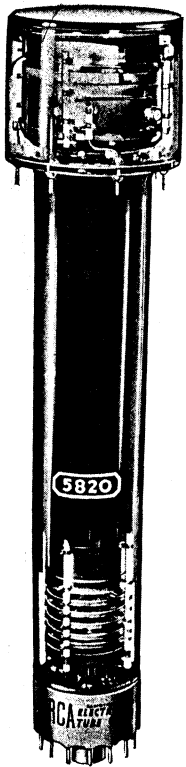
Light from the scene being televised is picked up by an optical lens system and focused on the photocathode which emits electrons from each illuminated area in proportion to the intensity of the light striking the area. The streams of electrons are focused on the target by the magnetic and accelerating fields.

On striking the target, the electrons cause secondary electrons to be emitted by the glass. The secondaries thus emitted are collected by the adjacent mesh screen which is held at a definite potential of about 2 volts with respect to target-voltage cutoff. Therefore, the potential of the glass disc is limited for all values of light and stable operation is achieved. Emission of the secondaries leaves on the photocathode side of the glass a pattern of positive charges which corresponds with the pattern of light from the scene being televised. Because of the thinness of the glass, the charges set up a similar potential pattern on the opposite or scanned side of the glass.

Scanning Section

The opposite side of the glass is scanned by a low-velocity electron beam produced by the electron gun in the scanning section. This gun contains a thermionic cathode, a control grid (grid No. 1), and an accelerating grid (grid No. 2). The beam is focused at the target by the magnetic field of an external focusing coil and the electrostatic field of grid No. 4.

Grid No. 5 serves to adjust the shape of the decelerating field between grid No. 4 and the target in order to obtain uniform landing of electrons over the entire target area. The electrons stop their forward motion at the surface of the glass and are turned back and focused into a five-stage signal multiplier, except when they approach the positively charged portions of the pattern on the glass. When this condition occurs, they are deposited from the scanning beam in quantities sufficient to neutralize the potential pattern on the glass. Such deposition leaves the glass with a negative charge on the



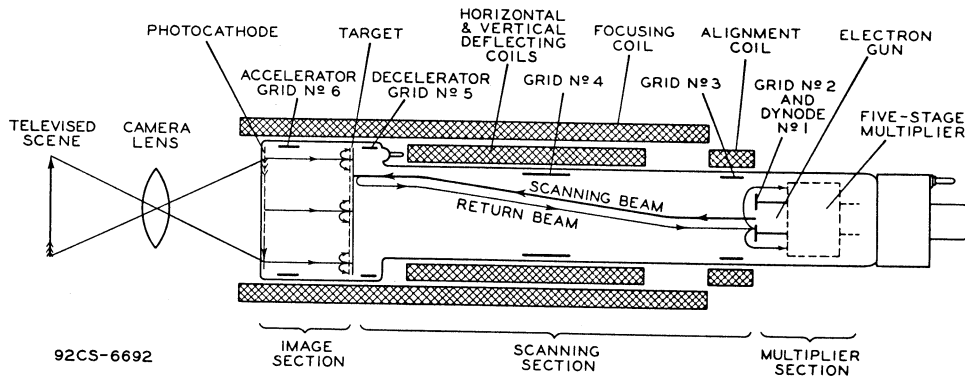


Fig. 1 - Schematic Arrangement of Type 5820.

scanned side and a positive charge on the photocathode side. These charges will neutralize each other by conductivity through the glass in less than the time of one frame.

Alignment of the beam from the gun is accomplished by a transverse magnetic field produced by an external coil located at the gun end of the focusing coil.

Deflection of the beam is accomplished by transverse magnetic fields produced by external deflecting coils.

The electrons turned back at the target form the return beam which has been amplitude modulated by absorption of electrons at the target in accord with the charge pattern whose more positive areas correspond to the highlights of the televised scene.

Multiplier Section

The return beam is directed to the first dynode of a five-stage electrostatically focused multiplier. This utilizes the phenomenon of secondary emission to amplify signals composed of electron beams. The electrons in the beam impinging on the first dynode surface produce many other electrons, the number depending on the energy of the impinging electrons. These secondary electrons are then directed to the second dynode and knock out more new electrons. Grid No. 3 facilitates a more complete collection by dynode No. 2 of the secondaries from dynode No. 1. The multiplying process is repeated in each successive stage, with an ever-increasing stream of electrons until those emitted from dynode No. 5 are collected by the anode and constitute the current utilized in the output circuit.

The multiplier section amplifies the modulated beam about 500 times. The multiplication so obtained maintains a high signal-to-noise ratio, and also permits the use of an amplifier with fewer stages.

The signal-to-noise ratio of the output signal from the 5820 is high. The gain of the multiplier

is such as to raise the output signal sufficiently above the noise level of the video-amplifier stages so that they contribute no noise to the final video signal. The signal-to-noise ratio of the video signal, therefore, is determined only by the random variations of the modulated electron beam.

It can be seen that when the beam moves from a less-positive portion on the target to a more-positive portion, the signal-output voltage across the load resistor (R_{25} in Fig. 2) changes in the positive direction. Hence, for highlights in the scene, the grid of the first video-amplifier stage swings in the positive direction.

DATA

General:

Heater, for Unipotential Cathode:	
Voltage (AC or DC)	6.3 ± 10% volts
Current	0.6 ampere
Direct Interelectrode Capacitance:	
Anode to all other electrodes.	12 μμf
Photocathode, Semitransparent:	
Response	See Fig. 3
Rectangular Image (4 x 3 aspect ratio):	

Useful size of	1.6" max. diagonal
Orientation of	Proper orientation is obtained when the vertical scan is essentially parallel to the plane passing through center of faceplate and pin No. 7 of the shoulder base.
Focusing Method.	Magnetic
Deflection Method.	Magnetic
Overall Length	15-3/16" ± 1/4"
Greatest Diameter of Bulb.	3" ± 1/16"
Shoulder Base.	Keyed Jumbo Annular 7-Pin
End Base	Small-Shell Diheptal 14-Pin (JETEC No. B14-45)
Operating Position	See Text
Weight (Approx.)	1 lb 6 oz
Minimum Deflecting-Coil Inside Diameter.	2-3/8"
Deflecting-Coil Length	5"
Focusing-Coil Length	10"
Alignment-Coil Length.	15/16"
Photocathode Distance Inside End of Focusing Coil.	1/2"

Maximum Ratings, Absolute Values:

PHOTOCATHODE:	
Voltage.	-550 max. volts
Illumination	50 max. ft-c



OPERATING TEMPERATURE:		
Of any part of bulb.	50 max.	°C
Of bulb at large end of tube (Target section).	35 min.	°C
TEMPERATURE DIFFERENCE:		
Between target section and any part of bulb hotter than target section	5 max.	°C
GRID-No.6 VOLTAGE.	-550 max.	volts
TARGET VOLTAGE:		
Positive value	10 max.	volts
Negative value	10 max.	volts
GRID-No.5 VOLTAGE.	150 max.	volts
GRID-No.4 VOLTAGE.	300 max.	volts
GRID-No.3 VOLTAGE.	400 max.	volts
GRID-No.2 & DYNODE-No.1 VOLTAGE.	350 max.	volts
GRID-No.1 VOLTAGE:		
Negative bias value.	125 max.	volts
Positive bias value.	0 max.	volts
PEAK HEATER-CATHODE VOLTAGE:		
Heater negative with respect to cathode.	125 max.	volts
Heater positive with respect to cathode.	10 max.	volts
ANODE-SUPPLY VOLTAGE*.	1350 max.	volts
VOLTAGE PER MULTIPLIER STAGE	350 max.	volts

Typical Operation and Characteristics:

Photocathode Voltage (Image Focus).	-400 to -540	volts
Grid-No.6 Voltage (Accelerator)-- 75% of photocathode voltage.	-225 to -375	volts
Target Voltage ^o	0 to 3	volts
Grid-No.5 Voltage (Decelerator).	0 to 125	volts
Grid-No.4 Voltage (Beam Focus)	140 to 180	volts
Grid-No.3 Voltage [#]	225 to 330	volts
Grid-No.2 & Dynode-No.1 Voltage.	300	volts
Grid-No.1 Voltage for Picture Cutoff	-45 to -115	volts
Dynode-No.2 Voltage.	600	volts
Dynode-No.3 Voltage.	800	volts
Dynode-No.4 Voltage.	1000	volts
Dynode-No.5 Voltage.	1200	volts
Anode Voltage.	1250	volts
Anode Current (DC)	30	μamp
Signal-Output Current (Peak to peak)	2 to 15	μamp
Target Temperature Range (See Text)	35 to 45	°C
Ratio of Peak-to-Peak Highlight Video-Signal Current to RMS Noise Current (Approx.).	35	
Minimum Peak-to-Peak Blanking Voltage.	5	volts
Field Strength at Center of Focusing Coil [▲]	75	gausses
Field Strength of Alignment Coil (Approx.)	0 to 3	gausses

* Ratio of dynode voltages is shown under *Typical Operation*.

^o Adjustable from -3 to +5 volts with blanking voltage off.

[#] Adjust to give the most uniformly shaded picture near maximum signal.

[▲] Direction of current should be such that a north-seeking pole is attracted to the image end of the focusing coil, with the indicator located outside of and at the image end of the focusing coil.

INSTALLATION

The *end-base pins* of the 5820 fit the small diheptal 14-contact socket. The *annular-base pins* fit the keyed jumbo annular 7-contact socket which should be rigidly fastened to the deflecting-coil assembly.

The 5820 has two complementary guides for inserting the tube correctly in the annular socket, i.e., the large pin (No.7) on the annular base, and the white radial line on the face of

the bulb. The annular socket should be positioned so that the key pin (No.7) of the annular base is in a vertical plane through the common axis of the deflecting-coil assembly and the focusing-coil assembly, and is at the bottom of the pin circle of the annular base.

The 5820 is installed by inserting the diheptal-base end of the tube through the coil assembly and then turning the tube until the annular-base pins, keyed by pin No.7, can be inserted in the annular socket. Proper insertion aligns the white radial line on the face with center of the key-pin hole in the annular socket. The diheptal socket is then put on the 14-pin base.

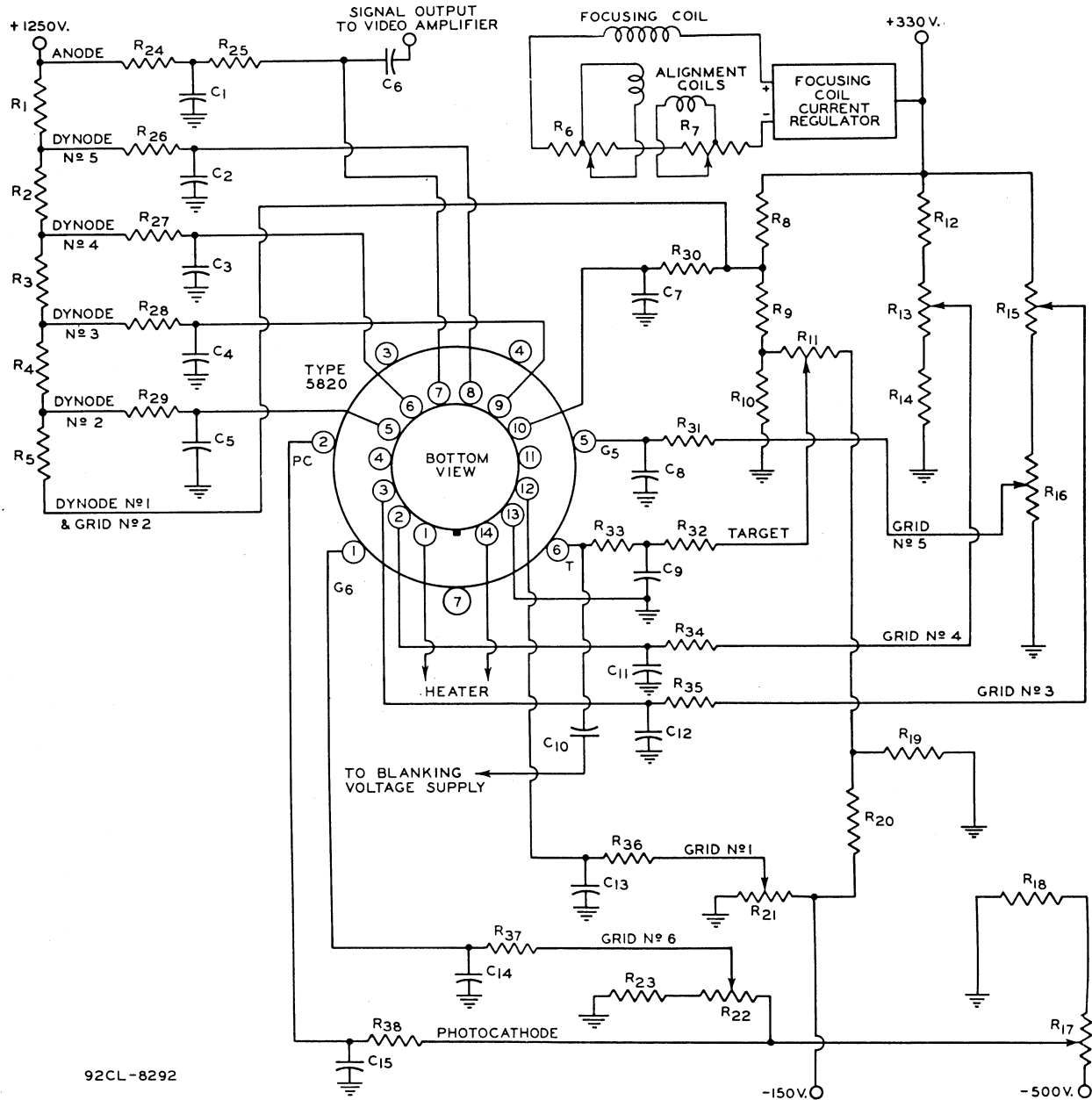
Proper orientation of the annular socket with respect to the horizontal-deflecting field is essential, and is obtained when the plane which is perpendicular to the plane of the annular socket and which passes through the center of the annular socket and the center line between pins 3 and 4 of the annular base is at right angles to the horizontal scanning field. This orientation minimizes beat-pattern effects by placing the sides of the mesh holes at an angle of 45° with respect to the horizontal scanning lines.

The *operating position* of the 5820 should preferably be such that any loose particles in the neck of the tube will not fall down and strike or become lodged on the target. Therefore, it is recommended that the tube never be operated in a vertical position with the diheptal-base end up nor in any other position where the axis of the tube with base up makes an angle of less than 20° with the vertical.

A *mask* having a diagonal or diameter of 1.6 inches should always be used on the photocathode to set limits for the maximum size of scan, and to reduce the amount of light reaching unused parts of the photocathode.

The *optical system* used with the 5820 should be designed according to basic optical principles and should incorporate an iris to control the amount of light entering the television camera lens. The entire optical system should have all inside surfaces finished in mat black to prevent internal reflections from reaching the photocathode. Under almost all conditions, the use of a lens shade is beneficial.

Proper shielding of the image section can be provided by wrapping around the outside of the focusing coil directly over the center of the deflecting coils a triple layer of Mumetal strip 0.006" thick and 5" wide, or equivalent. Then, wrap another triple layer of Mumetal strip 0.006" thick and 3" wide around the focusing coil directly over the image section of the 5820. Additional shielding is provided by fitting the inside of the focusing coil directly over the image section with a copper cylinder having a length of approximately 2-1/4" and a wall thick-



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|---|--|--|
| C1 C2: 0.05 μ f, 1600 v working voltage | R5: 270000 ohms, 1/2 watt | R18: 510000 ohms, 1 watt |
| C3: 0.01 μ f mica, 1600 v working voltage | R6 R7: 200-ohm potentiometer, center-tapped, 2 watts | R19: 11000 ohms, 1/2 watt |
| C4: 0.001 μ f mica, 1000 v working voltage | R8: 5100 ohms, 1/2 watt | R20: 310000 ohms, 1/2 watt |
| C5: 0.001 μ f mica, 600 v working voltage | R9: 51000 ohms, 2 watts | R21: 500000-ohm potentiometer, 1 watt |
| C6: 0.03 μ f mineral-oil impregnated, 1600 v working voltage | R10: 510 ohms, 1/2 watt | R22: 250000 ohms, 1 watt |
| C7 C8 C9 C11 C12 C13 C14 C15: 0.001 μ f mica, 400 v working voltage | R11: 150000-ohm potentiometer, 1/2 watt | R23: 560000 ohms, 1/2 watt |
| C10: 1 μ f, 400 v working voltage | R12: 100000 ohms, 1/2 watt | R24: 47000 ohms, 1/2 watt |
| R1: 47000 ohms, 1/2 watt | R13: 75000-ohm potentiometer, 1 watt | R25: 20000 ohms, 1/2 watt |
| R2 R3 R4: 220000 ohms, 1/2 watt | R14: 150000 ohms, 1/2 watt | R26 R27: 100000 ohms, 1/2 watt |
| | R15: 250000-ohm potentiometer, 1 watt | R28 R29 R31 R32 R34 R35 R36 R37 R38: 200000 ohms, 1/2 watt |
| | R16: 150000-ohm potentiometer, 1 watt | |
| | R17: 250000-ohm potentiometer, 1 watt | |
| | | R30: 50000 ohms, 1/2 watt |
| | | R33: 100000 ohms, 1/2 watt |

Fig. 2 - Voltage-Divider Circuit for Type 5820 with Recommended Arrangement for Connecting the Focusing Coil and Alignment Coils.



ness of 1/32". The Mumetal shielding effectively shunts the field-rate deflection field, while the copper cylinder shields the higher frequency line-scanning field from the electron path in the image section. Unless proper shielding is provided, "cross talk" from the deflecting yoke into the image section will result in loss of picture sharpness.

For the *high dc voltages* required by the 5820, the use of two pulse supplies for which the plate voltage is provided by a well-regulated, 330-volt, B-supply may be used. Each of these supplies should be actuated by the horizontal driving pulse which is obtained from the synchronizing generator. One of the pulse supplies should be capable of furnishing 1250 volts with an output current of 1 milliampere for the multiplier section; the other pulse supply should be capable of furnishing -500 volts with an output current of 1 milliampere for the image section. In addition to supplying the plate voltage and current for the pulse supplies, the 330-volt B-supply should also provide an output current of 90 milliamperes for the focusing and alignment coils and for the voltage divider which is used to supply the voltages for the electrodes in the scanning section of the 5820. Provision should be made for regulating the focusing-coil current.

A *voltage divider* to provide the required operating voltages for the various electrodes of the 5820 is shown in Fig. 2. It is to be noted that the blocking capacitor C_6 should be of the mineral-oil impregnated type to minimize capacitor leakage which will introduce disturbing effects into the picture.

In designing a voltage divider for the multiplier stages of the 5820, engineers should recognize that the dc output of individual 5820's may have a range of 15 to 1. This range, therefore, must be considered in the choice of bleeder-resistor values. If the values are too high, the distribution of voltages applied to the dynodes will be upset by a 5820 with a dc output at the upper end of the range. As a result, there will be an abrupt drop in the ac output of the tube as the beam current is increased. When this drop occurs before the beam is at its optimum value, the ratio of signal to noise will be lessened, and compression of the signal information will result.

Even with satisfactory bleeder-resistor values, it is possible to overload the tube itself. For 5820's having high dc outputs, a current reversal can occur at the 5th dynode stage of the multiplier as the beam current is increased. This current reversal will also produce a sharp drop in the ac output of the tube. To prevent such current reversal, it is recommended that provision be made to reduce the overall multiplier voltage for tubes with dc outputs at the upper end of the range. A reduction to 1000 volts should be adequate.

A *blanking signal* should be supplied to the target to prevent the electron beam from striking the target during the return portions of the horizontal and vertical deflecting cycles. Unless this is done, the camera-tube return lines will appear in the received picture.

The blanking signal is a series of negative voltage pulses. The voltage between pulses must be constant to prevent fluctuation of the target voltage. During the blanking periods, the full beam current without video-signal modulation is returned to the multiplier and its multiplied output flows through the load resistance. Excessive amounts of blanking voltage applied to the target will impair resolution, since during retrace the target is out of focus to the continuously flowing photocathode current. A desirable amount of target blanking is 6 volts peak to peak.

Shading may be required even with optimum adjustment of voltage on grid No. 3 in order to obtain a uniformly shaded picture. Sawtooth and parabolic waveforms of adjustable amplitude and polarity at both the vertical- and horizontal-scanning frequency should be provided for insertion in the video amplifier to aid in obtaining a flat background. The shading signal should be introduced in the amplifier after clamping is performed, since clamping circuits will remove the vertical-frequency shading component if added previous to the clamp-circuit location.

The *video amplifier* should be designed to cover a range of ac signal voltages corresponding to signal-output current of 1 to 15 microamperes peak to peak in the load resistor (R_{25} in Fig. 2). For bandwidth, refer to *Resolution* under OPERATING CONSIDERATIONS.

Failure of scanning even for a few minutes when light is incident on the photocathode may permanently damage the surface of the target. The damaged area shows up as a spot or line in the picture during subsequent operation.

To avoid damaging the 5820 during scanning failure, provision should be made to prevent automatically the scanning beam from reaching the target. The scanning beam can be prevented from reaching the target by (1) cutting off the scanning beam, or (2) making the target sufficiently negative. The scanning beam can be cut off by a relay which applies -115 to -125 volts bias to grid No. 1. The target can be made sufficiently negative by a relay which applies a bias of -10 volts to it. Either relay is actuated by a tube which is controlled by a portion of the scanning pulse voltage developed across either the horizontal or the vertical deflecting coils, or both. It is important to insure that in the event of failure of either the horizontal scanning pulse or the vertical scanning pulse, the circuitry should be capable of actuating the protection relay.



OPERATING CONSIDERATIONS

The *maximum ratings* in the tabulated data for the 5820 are limiting values above which the serviceability of the 5820 may be impaired from the viewpoint of life and satisfactory performance. Therefore, in order not to exceed these absolute ratings, the equipment designer has the responsibility of determining an average design value for each rating below the absolute value of that rating by an amount such that the absolute values will never be exceeded under any usual condition of supply-voltage variation, load variation, or manufacturing variation in the equipment itself.

New 5820's should be placed in service immediately upon receipt. They should be operated for several hours before being set aside as spares.

Spare 5820's should be placed in service for several hours at least once a month in order to keep them free from traces of gas which may be liberated within the tube during prolonged storage.

Rotation in the use of 5820's is recommended. After a 5820 is operated for 200 to 300 hours, it should be given an idle period of three or four weeks during which it generally will recover much of its original resolution and sensitivity.

Occasionally, a *white spot* which does not change in size when the beam-focus voltage is varied, may be observed in the center of the picture. Such a spot, especially if it is visible on the monitor with the camera lens capped, is probably an ion spot. If the spot begins to grow in size with continuous operation, the 5820 should be removed from service at once, and returned for re-processing. Continued operation of an image orthicon with an ion spot will eventually damage the target permanently.

The *spectral response* of the 5820 is shown in Fig.3 and is not subject to appreciable variation from tube to tube. The spectral response of the 5820 without correcting filter is shown by curve A in Fig.3. Curve B in this same figure, shows the spectral response when a Wratten No.6 filter is used with the 5820. This curve very closely approaches that of the eye shown by the dotted curve C. Use of the filter, which can be obtained with lens-adaptor ring at photographic-supply stores, results in a loss of sensitivity by about 2 to 1.

The *operating temperature* of any part of the glass bulb should never exceed 50°C, and no part of the bulb at the large end of the tube (target section) should ever fall below 35°C during operation. The temperature of the target is essentially the same as that of the adjacent glass bulb and can, therefore, be determined by measuring the temperature of the glass bulb adjacent to the target. For best results, it is recommended that the temperature of the entire bulb be held between 35° and 45°C. Operation at

too low a temperature will be characterized by the appearance of a rapidly disappearing "sticking picture" of opposite polarity from the original when the picture is moved. Operation at too high a temperature will cause loss of resolution and possibly permanent damage to the tube. Resolution is regained by waiting for the temperature to drop below 45°C. *No part of the bulb should run more than 5° hotter than the target section to prevent cesium migration to the target.* Such

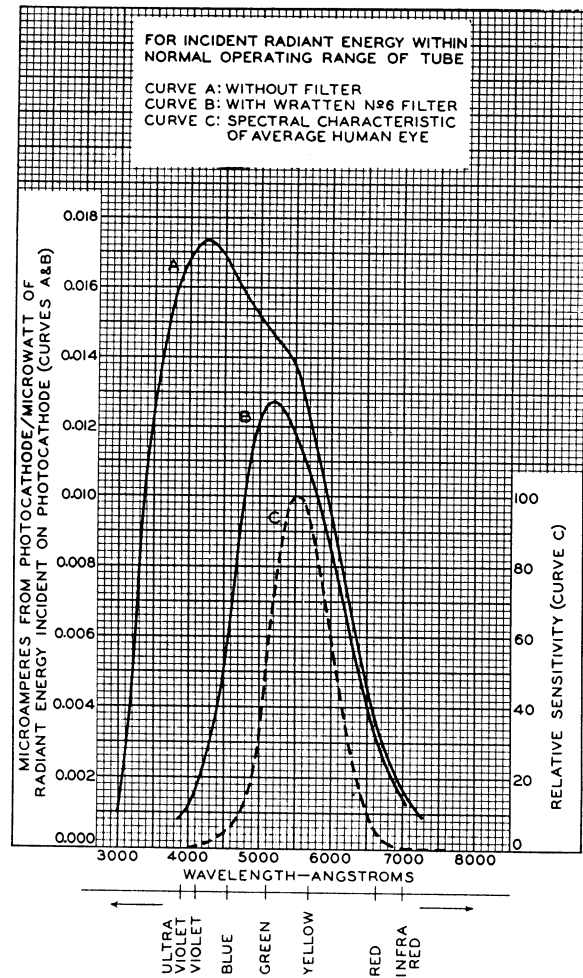


Fig.3 - Spectral Sensitivity Characteristic of Type 5820 With and Without Filter.

migration will result in loss of resolution and in probable permanent damage to the tube. Like other photosensitive devices employing cesium, the 5820 may show fluctuations in performance from time to time. Strict observance of the above recommendations with respect to operating temperature will not completely eliminate these variations but will greatly improve the stability of the characteristics during the life of the tube.

When the equipment design or operating conditions are such that the maximum temperature rating or maximum temperature difference as given under *Maximum Ratings* will be exceeded, provision should be made to direct a blast of cooling air from the diheptal-base end of the tube along the entire length of the bulb surface, i.e., through

low speed to prevent vibration of the 5820 and the associated amplifier equipment. Unless vibration is prevented, distortion of the picture may occur.

Ordinarily, the temperature in a camera equipped with a blower will not exceed 45°C, except in very hot weather or unless the target heater is left on accidentally for a long period.

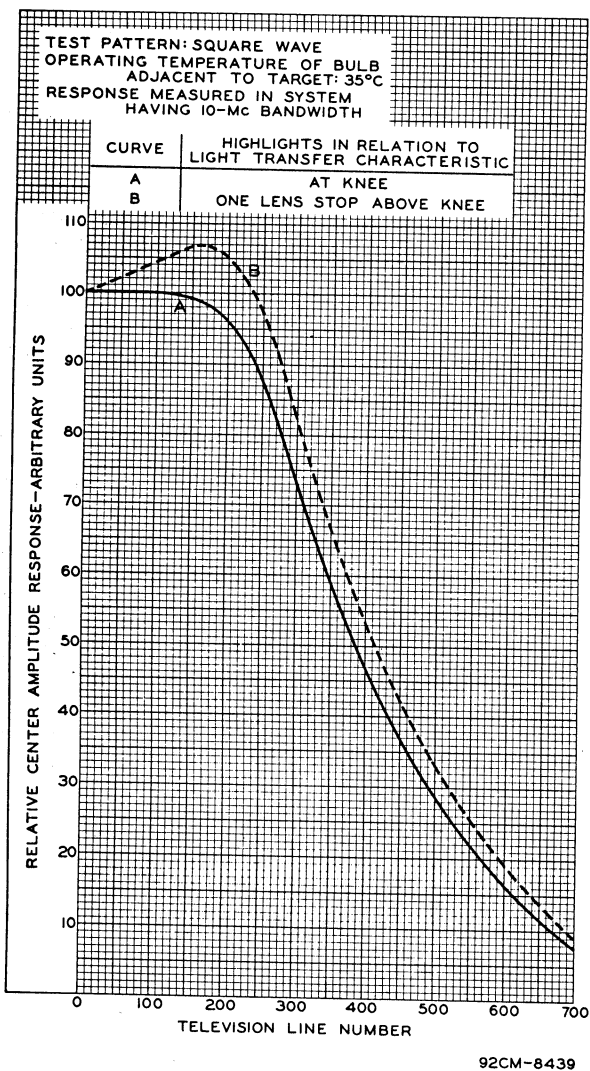


Fig. 4 - Amplitude Response Characteristics of Type 5820.

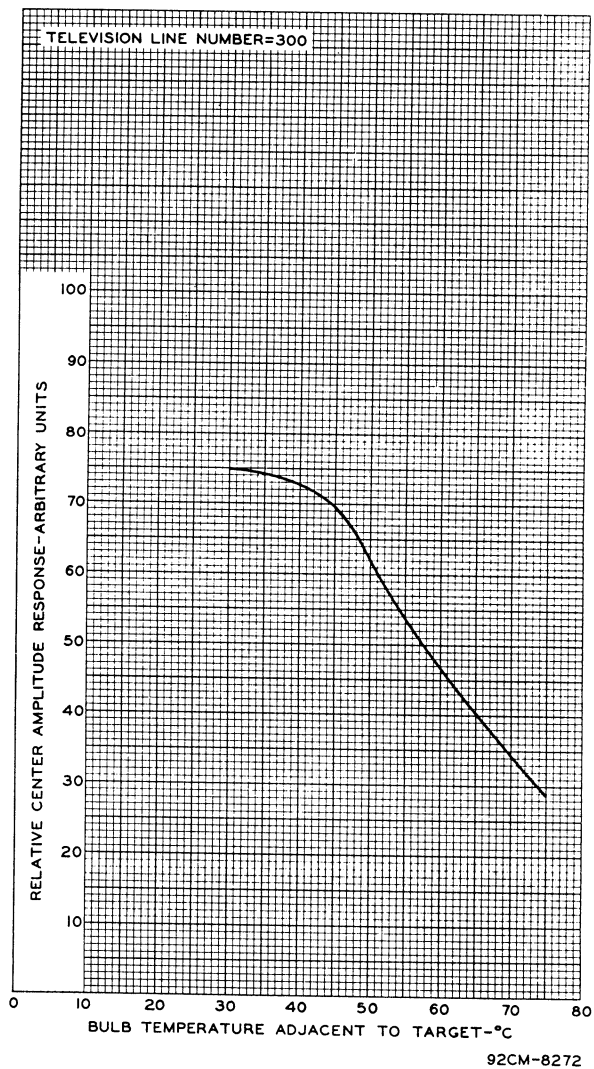


Fig. 5 - Temperature Effect on Amplitude Response of Type 5820.

the space between the bulb surface and the surrounding deflecting-coil assembly and its extension. Any attempt to effect cooling of the tube by circulating even a large amount of air around the focusing coil will do little good, but a small amount of air directly in contact with the bulb surface will effectively drop the bulb temperature. For this purpose, a small blower is satisfactory, but it should be run at

To keep the operating temperature of the large end of the tube from falling below 35°C, some form of controlled heating should be employed. Ordinarily, adequate heat will be supplied by the focusing coil, deflecting coils, and associated amplifier tubes so that the temperature can be controlled by the amount of cooling air directed along the bulb surface. If, in special cases, a target heater is required, it should fit between



The knee of the curve is explained by the fact that the charge accumulated by the target can not exceed the charge which raises the voltage of the target to the collector-mesh potential. As a result, when the 5820 is operated with highlights above the knee, not all of the secondary electrons emitted by the target glass disc are collected by the adjacent mesh, because it no longer maintains a positive accelerating field between itself and the charged areas. Those secondary electrons not collected fall back on their original location or are randomly distributed over adjacent picture areas. Since they land on these areas at a low velocity, they tend to discharge the positive areas and limit their charge buildup.

Operation with the highlights above the knee allows the image orthicon to develop an electrical signal that, in conjunction with the light-output characteristics of the TV receiver kinescope, presents a picture having normal tone rendition. In general, when operated with the camera lens stop opened one position beyond the point where the highlights of the scene reach the knee of the curve, the 5820 will produce a picture having very normal and pleasing tone rendition, especially for studio pickup where light levels and contrast range can be controlled.

For outdoor pickup where extreme scene brightness ranges are encountered, it will be necessary to operate the 5820 with the lens stop opened so that the highlights fall further than one stop above the knee. This setting is necessary in order that the extreme scene contrast can be compressed into the rather narrow contrast range reproducing capabilities of a television system without losing the information contained in the lowlight areas of the scene. Opening the lens stop two positions above the point where the highlights of the scene reach the knee will normally suffice in outdoor-pickup operation. If the lens stop is opened further, excessive black flare around bright objects will occur and random redistribution effects will produce a distorted picture.

Sensitivity and Illumination: The image orthicon is an ultra-sensitive device exceeding in relative sensitivity most high-speed photographic film. When related to photographic film and compared at shutter speeds of 1/30 second which is the storage time of the image orthicon in a television system, the 5820 with proper illumination will have an equivalent ASA exposure index between 500 and 1000. This equivalent film-speed rating can be used in conjunction with a photographic exposure meter to determine the approximate light level or lens-stop setting necessary for operating the 5820.

The illumination on the photocathode of the 5820 in relation to the scene illumina-

tion, can be determined by the following relationship:

$$I_s = \frac{4f^2 I_{pc} (m + 1)^2}{TR}$$

where

I_s = scene illumination in foot-candles

f = f-number of lens

I_{pc} = photocathode illumination in foot-candles

m = linear magnification from scene to target

T = total transmission of lens

R = reflectance of principal subject in scene

Except for very close shots, the linear magnification (m) from scene to target may be neglected.

For example, assume that the lens is $f:3.5$ having a transmission (T) of 75%, that the photocathode illumination is 0.015 foot-candle, and that the scene to be televised is composed largely of whites and blacks (such as a test chart) where the reflectance (R) may be in the order of 50%. Then,

$$I_s = \frac{4 \times 3.5^2 \times 0.015}{0.75 \times 0.50} = 2 \text{ foot-candles}$$

For average scenes where the principal subject has a reflectance of 5 to 10%, the incident illumination should have a value of 10 to 20 foot-candles.

The exact illumination for each 5820 as finally set up on the scene should be determined by observing on the video waveform monitor the light necessary to reach the knee of the transfer characteristic.

For very high illumination or for individual tubes with exceptionally high photocathode sensitivity, it may not be possible to stop the lens down far enough to reduce the highlight illumination on the photocathode to a value near the knee of the transfer characteristic. When such a condition is encountered, the use of a Wratten neutral filter selected to give the required reduction in illumination is recommended. Ordinarily, two filters--one having 10% transmission and the other 20%--will give sufficient choice. Such filters with lens-adaptor rings can be obtained at photographic-supply stores.

The low illumination level needed on the photocathode of the 5820 makes it necessary that no stray light from without or within the camera fall on the face of the tube. See *Optical System* under INSTALLATION.

The *setup procedure* for operating the 5820 is as follows: After the tube has been inserted in its sockets and the voltages applied as indicated under *Typical Operation*, allow it to warm up for 1/4 to 1/2 hour with the camera lens capped, and with grid-No.1 voltage adjusted to give a small amount of beam current. Make certain that the deflection circuits are functioning properly to cause the electron beam to scan the target.

the focusing coil and the bulb near the shoulder of the tube, and be non-inductively wound.

Full-size scanning of the target should always be used during on-the-air operation. Full-size scanning can be assured by first adjusting the deflection circuits to overscan the target sufficiently to cause the corners of the target to be visible in the picture, and then reducing the scanning until the corners just disappear. In this way, the maximum signal-to-noise ratio and maximum resolution can be obtained. Full-size scanning will also reduce the prominence of a beat pattern (see *Resolution*). Note that overscanning the target produces a smaller-than-normal picture on the monitor.

Underscanning the target, i.e., scanning an area of the target less than its sensitive area, should never be permitted. Underscanning produces a larger-than-normal picture on the monitor. If the target is underscanned for any length of time, a permanent change in target cutoff voltage of the underscanned area takes place with the result that the underscanned area thenceforth is visible in the picture when full-size scanning is restored.

Resolution in excess of 500 lines at the center of the picture can be produced by the 5820. The resolution curves in Fig. 4 show the relative center amplitude response versus television line number for the 5820 when it is operated with the highlights at the knee of the light transfer characteristic and at one lens stop above the knee (see text below) and at a temperature of 35°C. The values of response plotted on the curves are those obtained after optimum adjustments are made to minimize the prominence of beat patterns and dynode spots.

A beat pattern may be caused by the beating of the scanning lines against the lines of the target mesh. As a result, a moiré pattern, sometimes called a "swirl", appears in large-area highlights of the picture. Defocusing of the beam by adjustment of the beam-focus control (grid No. 4) may be helpful in reducing the beat-pattern effect. For additional way to minimize beat-pattern effects, refer to *Proper Orientation of the Annular Socket* under INSTALLATION.

A dynode spot is caused by a slight blemish on a dynode surface and appears as a white spot chiefly in the dark areas of the picture. Little defocusing of the beam is required to minimize the effect of dynode spots when the scene is brightly illuminated, but in dark scenes, the effect of dynode spots may be a limiting item on resolution.

Loss of resolution with increased bulb temperature adjacent to the target is illustrated

in Fig. 5. The loss of resolution is caused by the decreasing resistivity of the target glass disc with increasing temperature. As a result, lateral leakage of the image charge occurs.

To utilize the resolution capability of the 5820 in the horizontal direction with the standard scanning rate of 525 lines, it is necessary to use a video amplifier having a bandwidth of at least 6 megacycles. The maximum resolution obtainable is limited by the mesh-screen portion of the target.

Even with a wide-band amplifier, the resolution may be limited in the image section by "cross talk" caused by the scanning fields. Unless prevented by proper shielding from extending into the image section (see *Proper Shielding* under INSTALLATION), these fields will cause the electron image on the target to move at scanning frequency. As a result, the picture will lack definition.

Dynamic focusing may be employed to give more uniform focus from center to edge of picture, and to eliminate dynode pattern or texture in lowlight portions of a scene. Dynamic focusing is accomplished by applying to the beam-focus electrode (grid No. 4) a voltage with parabolic waveform consisting of mixed horizontal and vertical scanning frequencies. The peaks of the parabolic waveform should be negative and coin-

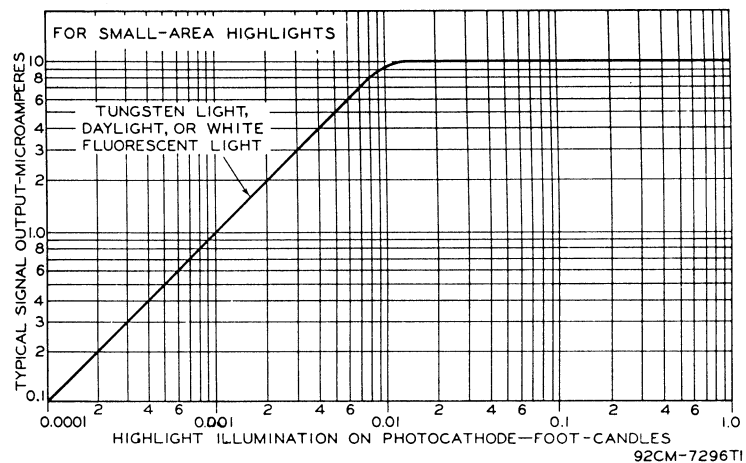


Fig. 6 - Basic Light Transfer Characteristic of Type 5820.

cident with those of the blanking signal. The dynamic-focusing voltage should have a peak-to-peak value of about 5 volts.

The *light transfer characteristics* of the 5820 change for different illumination levels (see Reference 6). The basic light transfer characteristic of the 5820 is shown in Fig. 6. This curve is representative only for small-area highlights. For larger-area highlights, the bend or "knee" is not quite as abrupt as shown in Fig. 6.



Adjust the deflection circuits so that the beam will "overscan" the target, i.e., so that the area of the target scanned is greater than its sensitive area. This procedure during the warming-up period is recommended to prevent burning on the target a raster smaller than that used for on-the-air operation. Note that overscanning the target results in a smaller-than-normal picture on the monitor.

With the lens still capped and the target voltage set at approximately 2 volts negative, adjust the grid-No.1 voltage until noise or a rough-textured picture of dynode No.1 appears on the monitor. Then adjust the alignment-coil current so that the small white dynode spots do not move when the beam-focus control (grid No.4) is varied, but simply go in and out of focus. During alignment of the beam, and also during operation of the tube, always keep the beam current as low as possible to give the best picture quality and also to prevent excessive noise and burn of the dynode-No.1 surface.

Next, uncap the lens and open the lens iris partially. Focus the camera on a test pattern. The target voltage is then advanced until a reproduction of the test pattern is just discernable on the monitor. This value of target voltage is known as the "target cutoff voltage". The target voltage should then be raised exactly 2 volts above the cutoff-voltage value, and the beam-current control adjusted to give just sufficient beam current to discharge the highlights.

Then adjust the lens to produce best optical focus, and the voltage on the photocathode as well as the voltage on grid No.4 to produce the sharpest picture.

At this point, attention should be given to the grid-No.5 and grid-No.3 voltage controls. Grid No.5 is used to control the landing of the beam on the target and consequently the uniformity of signal output. The grid-No.5 voltage control should be adjusted to produce a picture that has most uniform shading from center to edge with the lens iris opened sufficiently to permit operation with the highlights above the knee of the light transfer characteristic. The value of grid-No.5 voltage should be as high as possible consistent with uniform shading. Grid No.3 facilitates a more complete collection by dynode No.2 of the secondaries from dynode No.1. The grid-No.3 voltage control should be adjusted to produce the maximum signal output.

Now with a test pattern consisting of a straight line centered on the face of the 5820, adjust the voltage on grid No.6 along with the voltage on the photocathode to produce a sharply focused straight line on the monitor. Improper adjustment of the grid-No.6 voltage control will

result in the straight-line pattern being reproduced with a slight S-shape.

The above adjustments constitute a rough set-up of the 5820. Final adjustments necessary for the 5820 to produce the best possible picture are as follows: With the lens capped, realign the beam. Beam alignment is necessary after each change of the grid-No.5 voltage control and sometimes after each adjustment of the grid-No.3 voltage control.

The proper illumination level for camera operation should next be determined. Adjust the target voltage accurately to 2 volts above the target-cutoff value. Remove the lens cap and focus the camera on a test pattern. Open the lens iris just to the point where the highlights of the test pattern do not rise as fast as the low-lights when viewed on a video waveform oscilloscope.

Next, cap the lens and adjust the grid-No.3 voltage control so that the video signal when viewed on a video waveform oscilloscope has the flattest possible trace. This represents the black level of the picture.

The lens iris setting should then be noted, and the lens stop opened not more than one position beyond this point, unless extreme scene-contrast ranges necessitate opening the lens stop beyond this point.

The use of a higher value of target voltage than that recommended will shorten the life of the 5820. The target-voltage control should not be used as an operating control to match pictures from two different cameras. Matching of cameras should be accomplished by control of the lens iris openings.

Retention of a scene by the 5820, sometimes called a "sticking picture", may be experienced if the 5820 is allowed to remain focused on a stationary bright scene for several minutes, or if it is focused on a bright scene before reaching operating temperature in the range from 35° to 45°C. Often the retained image will disappear in a few seconds, but sometimes it may persist for long periods before it completely disappears. A retained image can generally be removed by focusing the 5820 on a clear white screen and allowing it to operate for several hours with an illumination of about 1 foot-candle on the photocathode.

To avoid retention of a scene, it is recommended that the 5820 always be allowed to warm up in the camera for 1/4 to 1/2 hour with the lens iris closed and with a slight amount of beam current. Never allow the 5820 to remain focused on a stationary bright scene for more than a few minutes, and never use more illumination than is necessary.



DOS and DON'TS
on Use of RCA-5820

Here are the "dos"--

1. Allow the 5820 to warm up prior to operation.
2. Hold temperature of the 5820 within operating range.
3. Make sure alignment coil is properly aligned.
4. Adjust beam-focus control for best usable resolution.
5. Give the 5820 an idle period every 200 hours.
6. Condition spare 5820's by operating several hours once each month.
7. Determine proper operating point with target voltage adjusted to exactly 2 volts above target cutoff.
8. Cap lens during standby operation.

Here are the "don'ts"--

1. Don't force the 5820 into its shoulder socket.
2. Don't operate the 5820 without scanning.
3. Don't underscan target.
4. Don't focus the 5820 on a stationary bright scene.
5. Don't operate a 5820 having an ion spot.

The significance of each of the above "dos" and "don'ts" in obtaining optimum performance from the 5820 is explained in the preceding pages of this bulletin.

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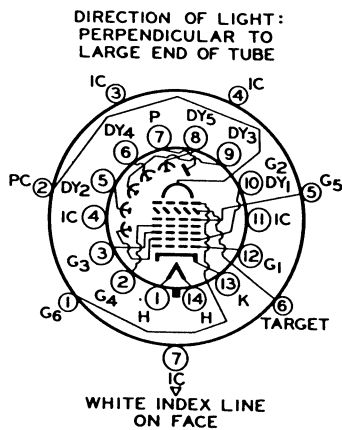
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SOCKET CONNECTIONS

Bottom View



SMALL-SHELL DIHEPTAL 14-PIN BASE

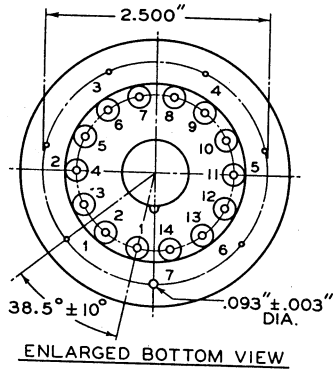
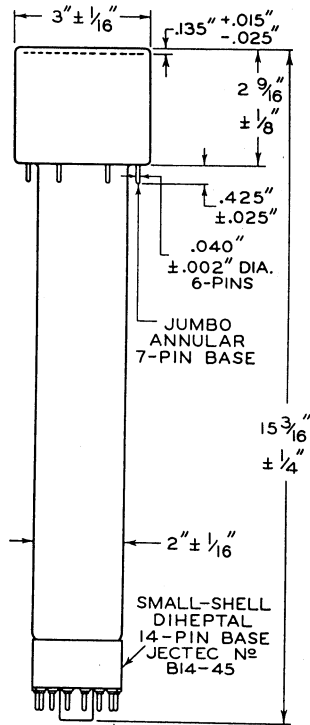
- | | |
|--|---|
| PIN 1: HEATER | PIN 9: DYNODE No. 3 |
| PIN 2: GRID No. 4 | PIN 10: DYNODE No. 1, |
| PIN 3: GRID No. 3 | GRID No. 2 |
| PIN 4: INTERNAL CONNECTION--DO NOT USE | PIN 11: INTERNAL CONNECTION--DO NOT USE |
| PIN 5: DYNODE No. 2 | PIN 12: GRID No. 1 |
| PIN 6: DYNODE No. 4 | PIN 13: CATHODE |
| PIN 7: ANODE | PIN 14: HEATER |
| PIN 8: DYNODE No. 5 | |

KEYED JUMBO ANNULAR 7-PIN BASE

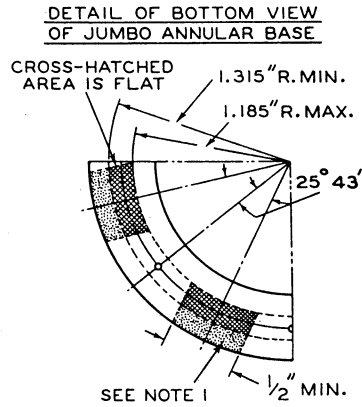
- | |
|--|
| PIN 1: GRID No. 6 |
| PIN 2: PHOTOCATHODE |
| PIN 3: INTERNAL CONNECTION--DO NOT USE |
| PIN 4: INTERNAL CONNECTION--DO NOT USE |
| PIN 5: GRID No. 5 |
| PIN 6: TARGET |
| PIN 7: INTERNAL CONNECTION--DO NOT USE |



DIMENSIONAL OUTLINE



ENLARGED BOTTOM VIEW



NOTE 1: DOTTED AREA IS FLAT OR EXTENDS TOWARD DIHEPTAL-BASE END OF TUBE BY 0.060" MAX.

ANNULAR BASE GAUGE

ANGULAR VARIATIONS BETWEEN PINS AS WELL AS ECCENTRICITY OF NECK CYLINDER WITH RESPECT TO PHOTOCATHODE CYLINDER ARE HELD TO TOLERANCES SUCH THAT PINS AND NECK CYLINDER WILL FIT FLAT-PLATE GAUGE WITH:

- SIX HOLES HAVING DIAMETER OF 0.065 ± 0.001 " AND ONE HOLE HAVING DIAMETER OF 0.150 ± 0.001 ". ALL HOLES HAVE DEPTH OF 0.265 ± 0.001 ". THE SIX 0.065 " HOLES ARE ENLARGED BY 45° TAPER TO DEPTH OF 0.047 ". ALL HOLES ARE SPACED AT ANGLES OF $51^\circ 26' \pm 5'$ ON CIRCLE DIAMETER OF 2.500 ± 0.001 ".
- SIX STOPS HAVING HEIGHT OF 0.187 ± 0.001 ", CENTERED BETWEEN PIN HOLES, TO BEAR AGAINST FLAT AREAS OF BASE.
- RIM EXTENDING OUT A MINIMUM OF $\frac{1}{8}$ " FROM $2-\frac{13}{16}$ " DIAMETER AND HAVING HEIGHT OF 0.126 ± 0.001 ".
- NECK-CYLINDER CLEARANCE HOLE HAVING DIAMETER OF 2.200 ± 0.001 ".

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